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VARYING ROCK RESPONSES AS AN INDICATOR OF CHANGES IN CO_2 - H_2O FLUID COMPOSITION; C.R.L. Friend, Dept. of Geology & Physical Sciences, Oxford Polytechnic, Headington, Oxon. OX3 OBP. U.K.

The formation of the late Archaean charnockite zone of southern India has been ascribed to dehydration recrystallisation due to an influx of CO_2 (1,2). PT conditions for the metamorphism have been calculated at about 750°C and 7.5 Kbar. The composition of the volatile species presently contained in fluid inclusions in the rocks changes across the transition zone. They are CO_2 dominated in the granulite facies and H_2O-rich in amphibolite facies rocks. Additionally they demonstrate a decrease in pressure northwards away from the granulite facies (3). At the time of charnockite formation it has been estimated that activity of water was less than 0.35 (3). The charnockite is superimposed across an anactectic granite, the Closepet granite, but in places sheets of granite cut the charnockite (4). This led to the hypothesis that the two events were contemporaneous and that anatexis had occurred as a result of the increase in water activity in front of the influx of CO_2 (5).

A study of the transitional zone was carried out at Kabbaldurga (Fig. 1) and it was recognised that the paths taken by the fluids could

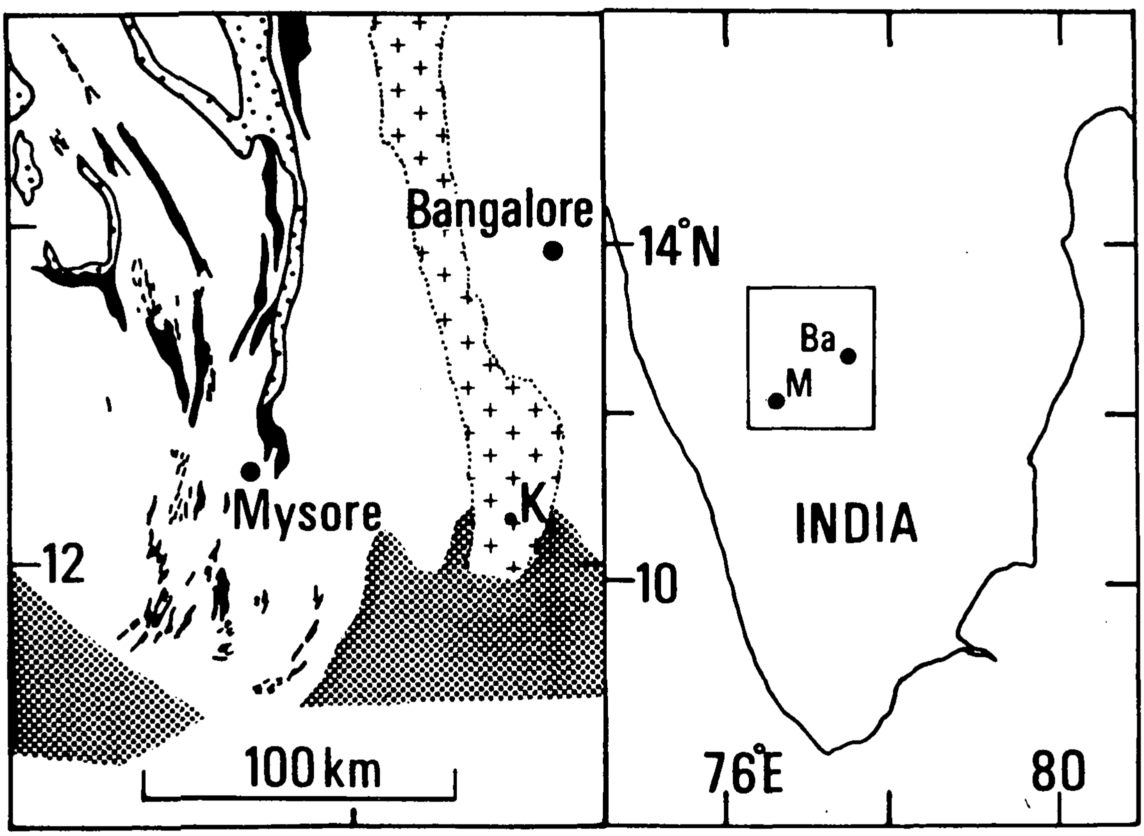

Fig. 1. Location of Kabbaldurga (K) and the charnockite zone (stipple). White = gneiss; black = Sargur supracrustal rocks; paired dots = Dharwar Super group.

be identified (6). In the charnockite terrain to the south, fluid migration appears to have been pervasive (cf. 7), the rocks having completely inverted to granulite facies assemblages (3), though some areas have been subjected to Proterozoic retrogression. However, at the transition zone it is clear that CO_2 migration was, at least initially, channelled (cf 7). The channels are picked out as brownish hypersthene-bearing veins superimposed over the structure of grey amphibolite facies gneisses and pinkish granites (2,4,5). This channelled migration was controlled either by the fabric of the rocks, foliation surfaces and lithological layering, or by structural features. Development along shear zones is common and a rectilinear network of veins, often oblique to the fabric of the rocks suggests that active stress patterns were controlling fluid movements along microfractures.

It was reasoned that since there is evidence of the movement of CO_2, as a result of dehydration effects upon the rocks, it may be possible to find a sequence of change laterally along a pathway (6). It is evident that the charnockite veins die out laterally (2,5) and by looking at the detailed structure of the veins a complete progression was recorded (6). Briefly this sequence passes from completely recrystallized charnockite into incipient charnockite, where there is occasionally, relics of the original structure, and then into a pathway along which only minor modification of the texture has taken place before passing into a reddened vein in the country rock. In this latter portion of the pathway it was concluded that the release of water by dehydration reactions had so modified the composition of the invading fluid that it was no longer capable of causing hydrates to breakdown, the reddening simply reflecting the passage of fluid.

The ingress of CO_2 is considered to have taken place into what initially was a closed system so that water flushed out from lower levels accumulated in front of the CO_2 advance and locally may have become ponded (8) causing local partial melting to occur in the amphibolite facies rocks. Subsequently channelled CO_2 created the network of charnockitic veins superimposed over the county rock fabric and structure (fig 2), which includes local zones of anatexis. Lateral change along the veins is explained by inhomogeneity in the fluid composition in the rock which locally may have had the ability to buffer the incoming fluids whilst elsewhere the system was flooded (cf 7).

At Kabbaldurga the passage of fluids may be attributed to channelled flow. However, important information may be gained which may help in understanding the flow regime in the totally inverted granulite facies rocks to the south where they appear to have suffered pervasive flow. In certain parts of Kabbaldurga quarry there are areas of totally inverted charnockite around which are arranged network arrays of charnockite veins (fig 2). In these areas the decrease in intensity of charnockite formation along the length of the pathway is evident over several metres. Between the veins cells of amphibolite facies rocks remain which decrease in size towards the area of charnockite (fig 2). In the areas of solid charnockite it would appear that pervasive flow of CO_2 has occurred. However, the evidence from the networks would suggest that two separate processes are going on. CO_2 has free access along the channels which are structurally held open, and the mafic phases are dehydrated to

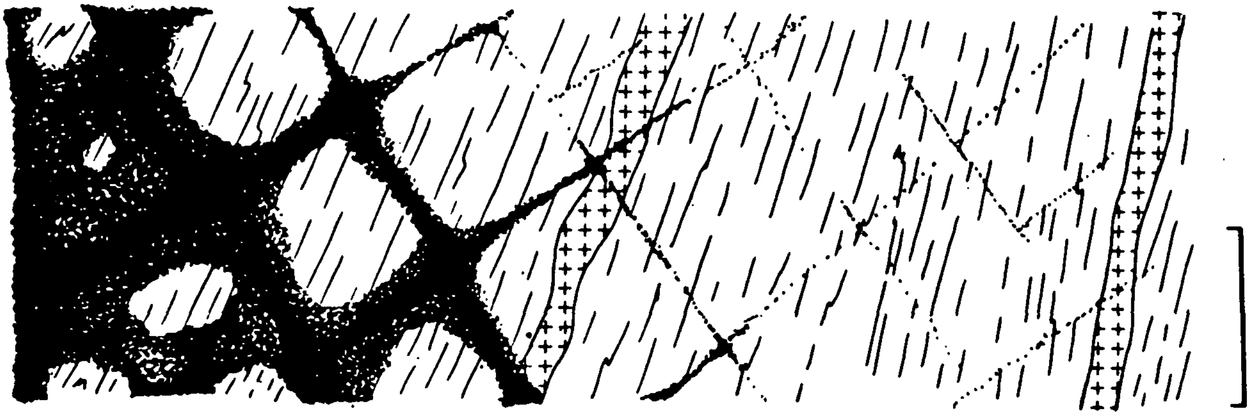

Fig. 2. Schematic plan of a segment of a charnockite area and surrounding network of veins (black), showing cells of amphibolite facies countryrock remaining (dashes = gneiss; crosses = granite). Scale bar = 1m.

orthopyroxene + a new biotite. The dehydration of the cells would appear to be a process which is controlled on a local scale by the rate of breakdown of hydrates along the walls of the main CO_2 channel. Clearly a H_2O is low in the channel, thus a gradient exists between the channel and the cell, where a H_2O is high. It is thus possible that fluid flow in the charnockites to the south was also channelled and not necessarily pervasive.

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